

Modern Concepts of Cardiovascular Disease

Published monthly by the AMERICAN HEART ASSOCIATION

50 WEST 50TH STREET, NEW YORK, N. Y.

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Vol. VI

June, 1937

No. 6

THE CONSIDERATION OF THE ARTIFICIAL DEVELOPMENT OF COLLATERAL CORONARY CIRCULATION BY SURGICAL MEANS

When the arterial blood supply to the heart is reduced either by experimental occlusion or by sclerosis of the coronary arteries, certain definite responses are elicited on the part of the heart. These responses consist of cyanosis of the myocardium, dilatation of the heart and a weak beat. The rate becomes rapid and irregular. The heart becomes irritable, and an ischemic trigger zone in the ventricles may set off ventricular fibrillation at any time. The physician prescribes rest, drugs, oxygen and food, and he hopes that ventricular fibrillation will not terminate his patient's life. If the heart beat is not terminated, certain adjustments in the coronary circulation take place both experimentally and clinically. One of these adjustments consists of a redistribution of the available blood to the heart so that ischemic trigger zones receive sufficient blood to reduce their irritability. This protects the myocardium from going into fibrillation. Another adjustment consists of an actual increase in the myocardial blood supply. Time is required for these adjustments to become established. After they are established, the medical regimen may be modified or even abandoned. Not infrequently these adjustments to an impaired myocardial circulation are inadequate to prevent fibrillation, and death occurs. The incidence of death from coronary diseases is appalling. Of the physicians who died in 1936, as listed in the *Journal of the American Medical Association*, a diagnosis of coronary thrombosis, coronary sclerosis or angina pectoris was given to 14 per cent.

The question arises as to whether an impaired myocardial circulation can be improved by operative measures. The first experiments on this subject were carried out by Beck about five years ago. He and Tichy produced coronary occlusion by placing silver bands around the coronary arteries close to their origins from the aorta. The silver bands were squeezed together at subsequent operations until the artery was completely occluded. At the first stage of these experiments the epicardium was removed and tissues (parietal pericardium, mediastinal fat,

skeletal muscle, omentum) were grafted upon the myocardium. It was possible to occlude completely the right coronary artery, the descending ramus of the left coronary artery and the circumflex branch of the left coronary artery with recovery of the dog. Anastomoses between the coronary bed and the extracoronary bed were demonstrated by injections of dye or barium, in either direction, i.e., from the heart into the grafts or from the grafts into the heart. In some of these experiments a free passage of the injection mass occurred and it was concluded that experimentally the heart could be given an additional supply of arterial blood by grafting tissues upon the myocardium. In some of the experiments the anastomoses were rich enough to justify application of this new surgical principle to patients suffering from coronary disease.

Only patients with advanced coronary disease and angina pectoris were selected for operation. The diagnosis was unequivocally established. In addition only those patients were selected who were completely incapacitated and who did not respond to prolonged rest and the usual medication. They constituted an extremely bad-risk group of patients for any surgical procedure. Up to the present time twenty patients have been operated upon. Of these there were twelve survivals (60 per cent) and eight deaths (40 per cent). A brief resume of the cases of four patients who seemed to receive the greatest amount of benefit from the operation follows:

Case I, a laborer, 48 years old, had arteriosclerotic heart disease and angina pectoris for nine years. He was totally incapacitated for one year. The operation was carried out on February 13, 1935. The patient returned to work and became self-supporting. He has no pain. The result is excellent.

Case II, a surgeon of fifty years with generalized arteriosclerosis; severe sclerosis of the vessels in the legs, diabetes mellitus, angina of effort for five years, coronary thrombosis one year and five months prior to operation during which time he was totally incapacitated. Operation was done July, 1935. The

SCIENTIFIC SESSIONS

The Thirteenth Scientific Sessions of the American Heart Association will be held in the Viking Room, Hotel Haddon Hall, Atlantic City, June 7 and 8, 1937. The program of the Section for the Study of the Peripheral Circulation will be given on Monday, June 7, and the general cardiac program on Tuesday, June 8.

The American Heart Association joins the American Medical Association in a heart symposium in Atlantic City, June 7-11. Don't fail to visit our exhibit booths at the Auditorium!

symptoms were not cured by the operation but he states that his result is decidedly worth while and that he got as much benefit as he anticipated. He continues to get pain but it is less severe, less frequent and his tolerance for exercise had definitely increased. His legs give him considerable trouble.

Case III, machinist of 55 years with generalized arteriosclerosis, angina of effort for two years, incapacitated from work for five months. Operation was done August, 1935. The patient claims that he is entirely relieved of pain. He returned to his former job as a machinist where he has worked steadily for the past year. His tolerance for exercise, as determined by means of the step test, is limited not by any precordial pain or discomfort, because he has none, but by the sclerosis of the femoral arteries.

Case IV, tailor of 42 years with angina pectoris for sixteen months following coronary thrombosis. He was totally incapacitated from his work for one year. Operation was done February, 1936. He claims that he is entirely free from pain. His tolerance for exercise has increased.

The results of the entire group are as follows: Eight patients have been observed over a sufficiently long period of time (5 to 23 months) to enable us to draw conclusions concerning the value of the operation. Five of the eight patients (62.5 per cent) have been relieved of their anginal pain completely and have been able to return to their pre-operative occupations (laborer, tailor, mechanic, painter, and clerk). Of the remaining three, one patient, the surgeon, has been relieved of his symptoms to a moderate degree. One patient is questionably improved; he has been relieved of his anginal pain but he remains very weak. The third patient, with early signs of left ventricular failure, died suddenly four months after the operation. This last patient lived outside of Cleveland and an autopsy was not obtained. This case was the only one in which powdered beef-bone exclusively was placed in the pericardial cavity. He was in failure at the time of operation and could not tolerate a more extensive procedure.

The operative procedure has been modified in order to reduce the mortality. Instead of exposing the heart from each side of the sternum, a unilateral approach is now used. The number of costal cartilages removed has been reduced to one or two. Smaller grafts of pectoral muscle have been placed upon the heart in the later operations. Procaine is applied directly to the myocardium to reduce the irritability of the heart when the epicardium is removed. We are also prepared to take care of ventricular fibrillation should this complication develop during the operation. Internal drainage is established into the left pleural cavity so that cardiac compression does not complicate the post-operative course. Fluid, as it forms, drains into the pleural cavity from which it can be removed by aspiration. Powdered beef-bone has been applied to the surface

of the heart to produce a low grade inflammatory reaction with its accompanying increase in the vascularity of the tissues. Irregularities of the heart are controlled by quinidine and digitalis. We give quinidine as a routine to every patient before an operation upon the heart is carried out. According to the experimental work of Mautz it makes the heart less irritable and may prevent ventricular fibrillation. We believe these various measures have helped to reduce the mortality. The last six patients have gone through the operation without a death.

Another factor that influences mortality is the condition of the patient prior to operation. Every patient whom we selected for operation was a poor surgical risk. It would be interesting to know the results of the operation in a group of patients with anginal pain but without evidence of severe myocardial fibrosis. A necropsy examination was carried out in six of the seven patients who died following operation. In all six there was extensive obstructive coronary disease and in three there was extensive myocardial infarction. All six had such extensive coronary disease as to be an adequate cause of death without consideration of the contributing influence of the operation.

Another point brought out by the experimental work concerns the effect of the grafts upon the movements of the heart. We have not been able to demonstrate any limitation of the cardiac movements by the grafts. In our experimental series (several hundred) we have never found cardiac failure or cardiac hypertrophy brought about by adhesions to the heart. These views have been corroborated by the experiments of Hosler and Williams. Indeed, we believe the established teaching that adhesions are instrumental in producing cardiac hypertrophy is not correct. Unless the adhesions produce angulation or torsion of the heart we believe they are silent and produce no functional disturbance.

At the present time we can scarcely make a statement concerning the future of this operation. We believe it is based upon a sound surgical principle. Anastomoses can be demonstrated experimentally. Of this there is no doubt. It is a qualitative demonstration rather than a quantitative demonstration. We do not know how many cubic centimeters of blood these channels can be made to deliver to the heart per minute. Why have some of our patients improved after operation? Why has the anginal pain subsided or why has it disappeared? Why has the patient become stronger? What do these facts mean in a quantitative way? These questions will be answered as further work is done. At present this work offers the beginning of a new method of approach in the treatment of a serious disease.

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ANNOUNCEMENT!

For the benefit of those who wish to save current issues of the "Modern Concepts of Cardiovascular Disease," we have had designed a handsome loose leaf binder, in green fabrikoid with gold stamping, which will accommodate fifty issues. The price is \$1.00 postpaid.

There are still available some copies of the bound volume containing the issues of 1932 to 1935 inclusive, with subject and author indices, price \$2.00, postpaid.

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